3.7 RISK OF EXPLOSION AND VIBRATION

Background information for this section is contained in Appendix XI, *Blasting and Vibration Analysis* prepared by SubTerra, Inc.

3.7.1 Affected Environment

Geology

The geologic conditions at the rock quarry site are described in the *Earth* section of this chapter.

Applicable Regulations and Regulatory Agencies

There are no State regulatory requirements addressing blast vibrations emanating from quarries. Blast vibration criteria contained in the federal regulations issued by the Federal Office of Surface Mines (OSM) for surface coal mining are considered by this federal agency to be suitable for quarry operations. The components of the Federal OSM surface mining regulations (30 CFR Parts 715, 815, 817) applicable to the operations at the quarry consist of the following:(a) Pre-blasting surveys; (b) Public Notice of Blasting; (c) Blasting Procedures - blasting restricted to daylight hours; and, (d) Blasting Standards – approaches for demonstrating the compliance of a blasting program with respect to structure damage.

The OSM regulations provide three possible approaches for demonstrating the compliance of a blasting program with respect to structural damage (OSM 1, 2 and 3). Only Methods 2 or 3 of the OSM guidelines are considered by the OSM to be relevant to rock quarry uses (OSM 1 standards are less stringent than OSM 2 and 3). The OSM Method 2 requires that blasting shots be designed using a specific formula establishing weight of explosives and distance to adjacent structures. The OSM Method 3 establishes various rock particle velocity (i.e. vibration) limits based on the weight of the explosives (refer to Appendix XI for a more detailed discussion on OSM Methods).

The OSM standards focus primarily on damage to surface structures and do not directly address human response or personal sensitivity to blast induced ground vibrations. Human sensitivity to various levels of peak particle velocity has been described as "noticeable" at 0.02 in/sec, "troublesome" at 0.2 in/sec and "severe" at 0.7 in/sec (Konya and Walter 1990). Experience at the Cannon Mine, which operated near the town of Wenatchee, Washington, showed that particle velocities in excess of 0.15 in/sec commonly triggered complaints (Bazdresch, 1993).

Blasting Procedures

Existing Monitoring

All blasting is currently conducted during daylight hours and according to a regular schedule that is provided to all residents within one-half mile of the quarry. A list of these residents was provided to Jefferson County.

Blast monitoring is currently performed inside site limits between the blast and the nearest residencies. The approximate location of the monitoring point is shown on Figure 1 of *Appendix XI*. As described further below, none of the monitored blasts have exceeded the threshold peak particle velocity / frequency limits suggested by OSM standards. The particle velocity at the most proximate structure to the quarry, located approximately 600-ft to the southwest, have been measured to be below the "noticeable" threshold cited by the OSM.

Flyrock

Lifters are sub-horizontal (almost horizontal) blastholes used to trim horizontal surfaces and minimize damage to large rock product. They are typically lightly loaded and fired under conditions of high confinement. Industry experiences indicate that there is some potential for flyrock to emanate from this type of blast. On rare occasions, flyrock from blasting on the Mats Mats Quarry site has traveled beyond the site boundaries.

3.7.2 Impacts of the Proposed Action

Rock would continue to be mined by drilling a series of holes into rock face benches and loading the holes with explosives and stem (material, usually crushed rock, placed in the holes to contain blast energy). Holes would be fired using non-electric delays which allow blast holes to detonate sequentially at intervals of a few milliseconds (thousands of a second). The rock loosened by the blasting would be removed from the bench by hydraulic shovel and transported by truck to the production facilities to produce rip rap, rockery rock, erosion control rock, crushed rock and fills. As under current operations, the number of blasts under the proposal would not exceed three per week. The hours for blasting would be limited to between 10:00 am and 4:00 pm Monday through Friday. Mining and associated blasting conditions would continue until approximately 2023 compared to 2005 without the *Proposed Action.*

Structural Stability

The closest off-site residence to the rock quarry is located approximately 600 feet southwest of the Quarry. At this distance, compliance with OSM Method 2 blasting standards would be anticipated to maintain peak particle velocities (movement of the ground) at proximate residencies below recorded complaint thresholds (0.15 in/sec) and well below levels of concern for structural damage (0.5 in/sec). This level of vibration has a near zero probability of structural damage to occur to residences constructed according to Uniform Building Code (UBC) standards, based on considerable empirical USBM blast monitoring data (Siskind, 1997). To verify the level of blasting related ground vibrations, ground vibration monitoring would be conducted. If vibration levels beyond acceptable standards are detected, the blasting techniques would be refined to ensure compliance. With proper adherence to the proposed blasting standards, no impacts to any structures would be anticipated from ground vibrations resulting from blasting.

Water Wells

The US Bureau of Mines (USBM) has investigated the impacts of blasting on bedrock water wells as part of in-house and sponsored research. Research indicated that blasting had little to no effect and that vibration below 2 in/sec would not cause damage to a well (P. R. Berger and

Associates, 1982). Thus, the criteria established to limit impacts to residential structures also ensure that wells would not be damaged.

Further studies conducted at the Sleeper mine in Nevada involved blasts that were detonated within and around rows of mine dewatering wells. This work indicated that wells remained undamaged even when blasting occurred within 30 feet of a well, with a charge weight (ANFO) per delay of 112 lbs., a scaled distance of 3, and a resultant peak particle velocity in excess of 8 in/sec (Rose, et al, 1991). Under the Applicant's proposal, the closest water wells would be located a minimum of approximately 400 feet from the quarry activity and would not be subject to peak particle velocities of greater than 0.5 in/sec. With the proposed blasting standards, no significant impacts to area wells are anticipated.

Flyrock

It is proposed that the blasting round be designed to fragment the rock and lift in place with minimum transport. Minimum stemming (depth of hole) would be maintained between 7 and 10 feet depending upon blast hole diameter. Blasting mats would also be used to further minimize the potential for flyrock. With the measures proposed to limit the potential for flyrock, no significant flyrock related impacts are anticipated.

3.7.3 Impacts of the Alternatives

No Action

Under the No Action Alternative, vibration and flyrock conditions would be similar to those under the Proposed Action. Blasting related to mining activities on the site would end by approximately 2005, compared to approximately 2023 under the *Proposed Action*.

Limited Mining

Under the Limited Mining Alternative, vibration and flyrock conditions would be similar to those under the Proposed Action. Blasting related to mining activities on the site would end by approximately 2013, compared to approximately 2023 under the *Proposed Action*.

3.7.4 Mitigation Measures

General

- Blasting would adhere to all state and federal blasting regulations.

- Before the blaster in charge would start loading any shot for blasting, he/she would first review the proposed blast with either the superintendent or another licensed blaster. The following items would be reviewed: the pattern (i.e., burden and spacing); the intended objective of the blast, rip rap or crusher run; the powder factor needed to achieve the objective; the timing of the delays to minimize vibration; the sequence in which the shot will be loaded; the set up of the seismograph between the blast and the nearest residence; and, the set up of the video camera to record the blast.

- Before loading any lifter shot, the blaster in charge would review the following items with the superintendent or another licensed blaster: the drill log would be reviewed to determine the amount of overburden on the back side of the proposed shot; and, determine whether a blast mat is required to negate all possibility of fly rock.

- The superintendent, the blaster in charge, and/or another licensed blaster would review every shot. Their notes and observations would be attached to the blast report.

Vibration

- All blasting will continue to be accomplished in daylight hours. A list of residents wishing to be contacted prior to commencement of any blasting will be kept on site.

- The blasting plan will limit blasting vibration to a level (peak particle velocity 1 in/sec at the site boundary using a scaled distance of 30) that has a near zero probability of structural damage to occur to residences constructed according to Uniform Building Code (UBC).

- To verify the level of blasting-related ground vibrations, ground vibration monitoring will be conducted consistent with US Office of Surface Mines Method 2 standards. If vibration levels beyond acceptable standards are detected, the blasting techniques will be refined to ensure compliance.

Flyrock

- Minimum stemming (depth of hole) would be maintained at 0.7 times burden or 8 feet, whichever is greater, to minimize flyrock.

- Blasts would be designed for: proper hole spacing and burden, proper powder factor, proper delay timing and sequencing, and minimum number of holes.

- When used, to the extent practicable, lifters would be oriented so that they do not point, or are oriented towards off-site structures.

- When applicable, blasting mats would be used to minimize the potential for flyrock.

- Sand-bagging or otherwise confining loaded lifters to further minimize flyrock.

- Care would be taken when preparing borings so that future bench blasts are not undercut to reduce underburdening at the toe and the potential for flyrock.

3.7.5 Significant Unavoidable Adverse Impacts

None are anticipated.